

London & Ed Phil May
with the Authors
Respect

482608

SILLIMAN, R.

SILLIMAN, R.

82114

REVIEW

OF A

SYSTEM OF MINERALOGY,

BY

JAMES D. DANA.

EXTRACTED FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XLVI.

NEW HAVEN:
PRINTED BY B. L. HAMLEN.

1844.



REVIEW, &c.*

It is seven years since we had the pleasure of announcing the first edition of this valuable work. (Vol. xxxii, p. 387.) The sale of a large edition of a book so purely scientific in this space of time gives good evidence alike of the growing interest in the subject in America, and of the high place which Mr. Dana's system holds in the estimation of mineralogists. During the period which has passed since the appearance of the first edition, the science of mineralogy has made rapid advances both in Europe and in this country. Abroad, many eminent chemists have been working up the obscure parts of the subject, and throwing new light on those better known. "The progress in analysis is especially apparent in the growing interest excited for the natural method of classification, and the opening prospect that, before long, the chemical and natural systems will be identical. There formerly seemed to be no bond of union between the species, hornblende, augite, tabular spar, acmite, and manganese spar, and in chemical methods we have found one with the ores of manganese, another with those of iron, another with salts of lime, and so on; but even Chemistry now suggests the natural system of arrangement, and demands their union in a single family, as given in some of the latest chemical treatises. Numerous other

* System of Mineralogy, including the most Recent Discoveries, Foreign and American; 640 pp. large 8vo, with 320 Wood Cuts, and four Copper Plates, containing 150 additional Figures. By JAMES D. DANA, A. M. London and New York, Wiley & Putnam, 1844.

instances, given in our remarks on Classification, illustrate the fact that the natural system is founded actually on chemical principles."—*Preface.* On this side the water, the numerous geological and mineralogical surveys which have been commenced or brought to a close, have done much to diffuse a taste for such studies among the mass of the people, and to awaken a spirit of inquiry, which, under the direction of the eminent gentlemen charged with the several parts of the work, has developed to a good degree our mineralogical resources. "Sources of information have thus been laid open for making a thorough American work on Mineralogy ; and it has been the endeavor of the author to avail himself fully of these various aids, to render, if possible, the present treatise deserving of this title." Many new species have been added to our former lists, and doubtless many proposed which are not new. Many old ones have been made to coalesce with others previously established,* while old names that had been discarded are again brought into use.†

The following catalogue contains the more interesting of the new foreign species added to this edition of Mr. Dana's treatise.

Apatelite.	Beaumontite, (crenate of copper.)	Greenovite.
Potash copperas.	Bromic silver.	Perowskite.
Soda copperas.	Iodic mercury.	Œrstedite.
Oxalate of lime.	Rosite.	Mosandrite.
Pissophane.	Hydrargillite.	Wöhlerite.
Leucophane.	Gigantolite.	Euxenite.
Magnesian pharmaco- lite.	Villarsite.	Uranotantalite.
Bromlite.	Lepidomelane.	Heteroclin.
Romeine.	Hydrous mica.	Anthosiderite.
Antimonophyllite.	Ryacolite.	Wehrlite.
Nussierite.	Andesine.	Irite.
Selenate of lead.	Oligoclase.	Placodine.
Volborthite.	Periclase.	Xanthokon.
Delevauxene.	Rhodizite.	Zinkenite.
		Geocroneite.

* "Among the species that have disappeared, the following are the most important: Comptonite, united with Thomsonite; Biotine, with Anorthite; Elæolite, Davyne, Cancrinite, and Gieseckite, with Nepheline; Mellilite, with Humboldtite; Junkerite, with common Spathic Iron; Levyne, Gmelinite, and Phacolite, with Chabazite; and Gismondine, including Aricite and Zeagonite, with Phillipsite."—*Preface.*

† The celebrated works of Von Kobell and Rammelsberg, and the new edition of Mohs's System, have also been published since 1837.

Plagionite.	Pyrosclerite.	Fichtelite.
Voltzite.	Thrombolite.	Könlite.
Greenockite.	Variscite.	Hartite.
Faujasite.	Krisuvigite.	Ixolyte.
Malthacite.	Kammererite.	Guyaquillite.
Ottrelite.	Fossil copal.	Berengelite.
Pelokonite.	Middletonite.	Pigotite.
Praseolite.		

It is surprising, considering the correctness of this treatise on its first appearance, to find how numerous and important are the changes which have been made in the present edition.

In the volume already quoted, we have given a full outline of the plan and general arrangement of Mr. Dana's work, which it is the less necessary to repeat at present, since the first edition is in the hands of so many of our readers. The mathematical appendix of the first edition is omitted in most of the present one; only a few are bound up with it for the satisfaction of those who wish to pursue that portion of the subject. Notwithstanding this omission, the present edition is considerably larger than the former—the whole amount of new matter being little short of one hundred and fifty pages. It is in fact to all intents and purposes a new book, modelled on the general plan of the former, but altered in many important points to suit it to the present advanced state of the science. Without farther preface, therefore, we proceed to give in as condensed a form as possible some of the novel features of greatest interest which strike our eye in the work, following the order of the contents.

Irregularities of Crystals.—Under this head, (which constitutes the 3d chapter,) we have an important addition, and an able exposition of a subject which is the cause of much perplexity to the student, and, when rightly understood, unfolds many difficulties and apparent anomalies, both in the form and composition of minerals. The irregularities of crystals are treated of under four heads. 1. Imperfections of surface; 2. Variations of form and dimensions; 3. Internal imperfections and impurities; 4. Pseudomorphous crystallizations. Under the first head we have—

1. *Striated Surfaces.*—“These are produced by minute planes covering the surfaces striated, and usually inclosed parallel to the seconda-

ry or primary planes of the crystals, and we may suppose these ridges to have been formed by a continued oscillation in the operation of the causes that give rise, when acting uninterruptedly, to enlarged planes. By this means the surfaces of a crystal are marked in parallel lines meeting at an angle, and constituting the ridges referred to. This combination of different planes in the formation of a surface has been termed the *oscillatory combination*. The horizontal striæ on prismatic crystals of quartz, (Fig. 1,) are examples of this combination, in which the oscillation has taken place between the prismatic and pyramidal planes. As the crystals lengthened, there was apparently a continual effort to assume the terminal pyramidal planes, which effort was interruptedly overcome by a strong tendency to an increase in the length of the prism. In this manner, crystals of quartz are often tapered to a point, without the usual pyramidal terminations."

"Diagonal striæ sometimes occur on the faces of a cube showing an oscillatory combination between the cube and octahedron. The rhombic dodecahedron is often striated parallel either with the *longer* or the *shorter* diagonal of its faces; the *former* resulting from an oscillatory combination of the dodecahedron with the regular octahedron, and the *latter*, with the cube or planes bevelling the edges of the cube, as in *Aplome*. The accompanying figure represents a distorted crystal of magnetic iron from Haddam, Ct., illustrating the oscillation between the octahedron and dodecahedron. The faces of trapezohedral garnets are often striated parallel with the symmetrical diagonal, showing an oscillation with the dodecahedron."

2. Variations in the forms and dimensions of Crystals.—"The simplest modification of form in crystals, consists in a simple variation in length or breadth, without a disparity in similar secondary planes. The distortion, however, extends very generally to the secondary planes, especially when the elongation of a crystal takes place in the direction of a diagonal, instead of the crystallographic axes. In many instances, one or more secondary planes are *obliterated* by the enlargement of others, proving a source of much perplexity to the young student. The interfacial angles remain constant, unaffected by any of these variations in form.

"As most of the difficulties in the study of crystals arise from these distortions, this subject is one of great importance to the student."

Fig. 1.

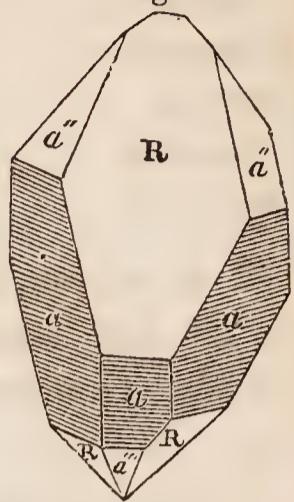
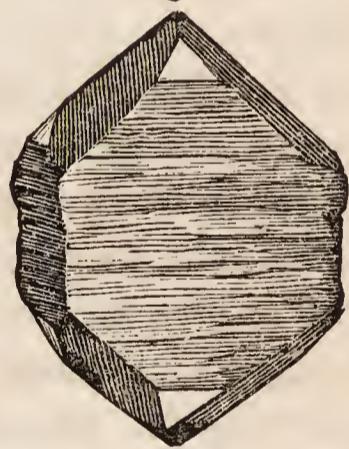


Fig. 2.



Following the order of his crystallographic system, Mr. Dana unfolds this intricate subject by a beautiful series of figures, of which we can notice only the following:—

“Figure 3 represents a crystal of Galena from Rossie. It is a shortened cube; the lateral faces are very irregularly curved, and consist of the primary faces of the cube and the planes truncating the lateral edges. Some of the terminal edges are also truncated. The crystal is surrounded by a low pyramid, consisting of four planes on each of the angles and edges, which, owing to the distortion, do not occur elsewhere on the crystal. The cleavages of the crystal easily explain the relations of the several planes to the primary.”

“Figure 5 of apatite is the same form that is represented in figure 4, but greatly distorted. The planes e' , e , e'' , between P and the right M,

Fig. 4.

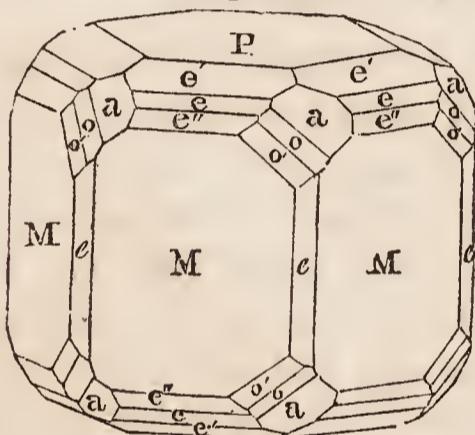
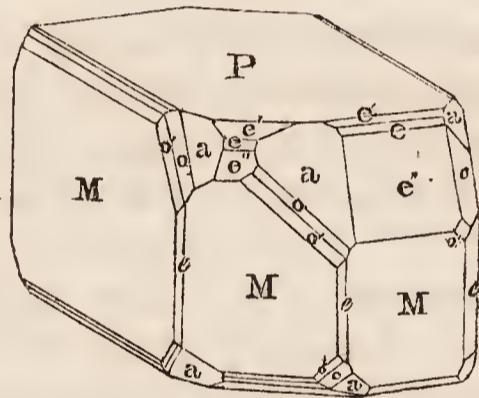


Fig. 5.



are enlarged, while the corresponding planes below are in part obliterated. By observing that similar planes are lettered alike, the two figures may be compared throughout.”

Fig. 7.

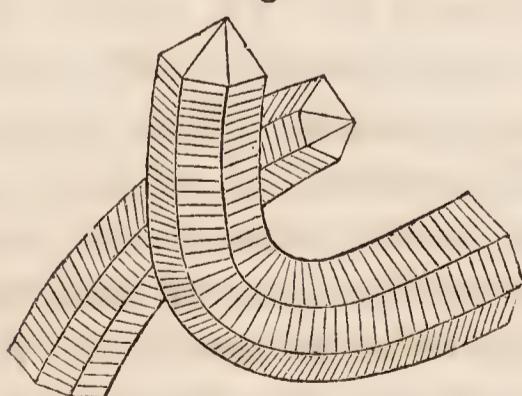
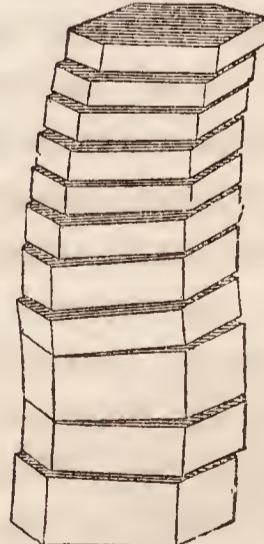


Fig. 6.



“*Curved Crystals.*—Curves in imbedded crystals are of frequent occurrence; and in implanted crystals they are not very uncommon. The annexed figure of quartz, (fig. 6,) illustrates this kind of distortion; the

same is described by Beck as occurring in the apatite of St. Lawrence Co., N. Y. Six-sided prisms of calc spar are occasionally curved in the same manner.

"In many species the crystals appear as if they had been broken transversely into many pieces, a slight displacement of which has given a curved form to the prism. This is common in tourmaline and beryl. The beryl from Monroe, Ct., often presents these interrupted curvatures as represented in figure 7."

In Vol. XLII, p. 206, of this Journal, Dr. John Locke described some very curious instances of curved crystallizations of gypsum, from Mammoth Cave, in Kentucky. Mr. Dana has given two excellent figures of this species of distortion, drawn from specimens in the collections of the National Institute at Washington. Sir John Herschel has also described similar forms in ice on the stalks of plants, (Phil. Mag. 1833, II, 110,) and we had the pleasure of observing the same phenomenon recently on the stalks of the *Helianthemum corymbosum* and *H. Canadense*.

"*Variations in the Angles of Crystals.*—Variations in the angles arising from curvatures and imperfections of surface have been alluded to. Other variations are owing to impurities in the crystal. Calcareous spar is one of the most noted instances of this variation; it varies from 105° to $105^{\circ} 17'$. Pure crystals have the constant angle $105^{\circ} 5'$. These variations are in general so small as seldom to cause any difficulty in practice. Secondary planes, lustre, cleavage, and other peculiarities, will always distinguish a cube from a square prism, although the angles differ but $1''$ from one another.

"From the investigations of Mitscherlich it is ascertained that the angles of crystals vary with the temperature. In passing from 32° to 212° F., the angle of calc spar was diminished $8\frac{1}{2}'$, thus approaching the form of a cube as the temperature increased. Dolomite, in the same range of temperature, diminished $4' 6''$. The angle of the prism of aragonite was increased $2' 46''$ while passing from 63° to 212° F."

3. *Internal imperfections and impurities.*—This is a head capable of much expansion. The controlling influence exerted by the menstruum or medium, while minerals are taking on their forms, particularly as regards the chemical constitution of species, has not hitherto received sufficient attention. We have no doubt that when this subject has been thoroughly investigated, much of the present complexity of the formulas given for many species will vanish, and the small per cent. of many matters discovered by chemical analysis and not essential to

the existence of the mineral as a normal chemical salt, will prove to be only mechanical mixture. Indeed, already we discover with pleasure a disposition in foreign chemists of eminence, to simplify as far as possible their formulas. Mr. Dana has in his preface the following judicious remarks on this subject.

" Notwithstanding the well-known principle that crystallizing substances may include, mechanically, the impurities present in a solution, a fact often discoverable with the naked eye, chemists very generally include in the formula every ingredient obtained by analysis, however small the proportion. In some species, as quartz, lime, heavy spar, celestine, macles of andalusite, auriferous pyrites, and a few others, mechanical mixtures are allowed ; but in most cases, especially if the mineral be a complex one, mechanical impurity seems hardly to be thought of as a possibility : while, in truth, the detection of an ingredient, in small quantity, in an opaque crystallized mineral, is neither proof of its mechanical, nor of its chemical combination ; and some farther evidence should be required before coming to any conclusion on this point. Had the possibility of mechanical mixtures been more considered, and a doubt indulged when chemistry seemed to clash with crystallography, the science would have been encumbered with fewer synonyms. As an example :—the Peristerite of a British chemist would have been left in undisturbed union with feldspar : it requires but a common magnifier to detect the impurities (minute spangles, apparently of mica) in the red stripes of this red-and-white iridescent feldspar from Upper Canada ; and it is very probable that quartz may be segregated, on known principles, in the white stripes, like the mica in the red. These facts explain the peculiar composition of this mineral, the analysis of which Rammelsberg quotes with expressions of distrust ; and if their bearing on the composition of other minerals were admitted, we should find the chemist less hasty in urging forward new species on chemical grounds alone."

The impurities often take a symmetrical arrangement, generally collecting most abundantly about the centre and along the diagonal, and also in planes between the centre and edges of the crystal. In chiastolite the foreign matter is arranged about the central axis, and in planes running from this axis to the edges, and also about the lateral edges and exterior surfaces of the crystal. The accompanying figure, illustrating these principles, represents a macle of Staurotide, discovered by Dr. C. T. Jackson, resembling those of

Fig. 8.



Andalusite. The mica from Jones' Creek, near Baltimore, contains opaque lines or bands in concentric hexagonal figures which arise from the same cause. p. 54.

Section 11. *Crystallogeny*.—This section is divided into two parts.

1. The *theoretical* part, containing the various theories which have been adduced to account for the structure of crystals, and a particular illustration of that which appears to be most consistent with facts.

2. The *practical* part, including the different processes of crystallization and the attendant circumstances.

The original and profound views of the author on the following questions—"What are the laws by which molecules are superimposed on molecules in perfect order, and these tiny yet wonderful specimens of architecture constructed? What is this crystallogenic attraction? What the nature of the ultimate particles of matter?"—are unfolded in the early part of this section. He gives in the first place, a succinct account of the history of the subject, which is one that has exercised the ingenuity of the most profound philosophers. It has been before said in this Journal, (Vol. xxxii, p. 388,) that "after much examination of this matter, we do not hesitate to declare our opinion, that this mysterious problem, which since the days of Epicurus has been so often unsuccessfully attacked, is at length here solved."* It is a satisfactory circumstance that this somewhat bold conclusion has been borne out by the evidence of so great an authority as M. Necker, who has fully recognized the correctness of Mr. Dana's views. (*Bibliothèque Universelle*.)

Under the heads of *isomorphism* and *dimorphism*, the recent views of Dr. H. Kopp are introduced, (p. 88,) as well as those of Mitscherlich and Rose.

"*Isomorphism*.—The isomorphism of certain substances must be attributed to some similarity in the nature of the molecules, in consequence of which they produce, in their combinations, compound molecules of similar ellipsoidal form and similar axes. Lime and protoxyd of iron are thus allied, and the qualities of their molecules are so alike, that, on uniting with the same substance in like proportions, the compound molecule has nearly or quite the same form, and similarly ar-

* Mr. Dana's article on the formation of crystals, may be found at length in this Journal, Vol. xxx, p. 275.

ranged axes. Dr. H. Kopp has lately shown that isomorphic bodies have equal atomic volumes, and draws the conclusion that isomorphism is owing to an equality in the volume of the atoms, or plesiomorphism to an approach to equality. Those bodies that replace one another without changing the crystalline form, have atoms of equal volumes, and their isomorphous compounds are also equal in atomic volume. He obtains the atomic volume by dividing the atomic weight by the specific gravity, and thus shows for a great number of the acknowledged isomorphous or rather plesiomorphous minerals, a close approach to one another, in the volumes of their atoms. For example, for the carbonates of zinc and magnesia, mesitine, carbonates of iron and manganese, dolomite, and calc spar, he found the atomic volume as given in the following table :

	Atomic volume.	Axis <i>a</i> .	Angle.
Carbonate of Zinc,	175·33	0·807	107° 40'
Carbonate of Magnesia,	181·25	0·812	107 25
Mesitine,	186·26	0·815	107 14
Carbonate of Iron,	188·50	0·819	107 0
Carbonate of Manganese,	202·29	0·822	106 51
Dolomite,	202·36	0·833	106 15
Calc Spar,	231·20	0·854	105 15

"The above table, which contains also the axis *a*, and the angle of the rhombohedron, of each of these minerals, illustrates the interesting fact, which he next deduces, that the axis increases, or the angle diminishes, as the atomic volume increases. He also derives a formula for calculating the volume from the length of the axis, and finds it to give results coinciding very nearly with the above. These principles are illustrated by numerous examples, for which reference may be had to Brewster's Philosophical Magazine for April, 1841, p. 255.

"Since an increase of atomic volume is connected in the above minerals with an increase of the axis *a*, and heat, by diminishing the density, necessarily increases the volume of the atom, therefore the axis *a* must be lengthened by heat, as is actually the case. Mitscherlich found the specific gravity of calc spar diminished by a heat of 180° F. in the proportion $1 : \frac{1}{1.001961}$, and Dr. Kopp, by calculation determines that for 180° F. the angle of the crystal should be changed 7' 37", which is but 57" less than Mitscherlich's observations—a near coincidence, when we consider the difficulties which necessarily accompany the direct measurement of the dilatation and change of angles.

"These principles proceed on the hypothesis of simple *spherical* or *spheroidal atoms* for compound bodies, and the theory of atoms proposed by the author receives from them strong confirmation.

"*Dimorphism*.—Dimorphism has been shown by Mitscherlich, Rose and others, to result in many instances from the different temperatures

attending crystallization. When a *right rhombic* prism of sulphate of zinc is heated to 126° F., certain points in its surface become opaque, and from these points bunches of crystals shoot forth, in the interior of the specimen ; and in a short time, the whole is converted into an aggregate of these crystals diverging from several centres on the surface of the original crystal. These small crystals thus formed at 126° F., are *oblique* rhombic prisms ; and the same form may be obtained by evaporating a solution, at this temperature, or above it. Sulphur crystallizes from fusion in oblique rhombic prisms, while the common form obtained by evaporation is a rhombic octahedron. Rose has obtained crystals of arragonite by evaporating a solution of carbonate of lime to dryness by means of a water bath, and crystals of calc spar by permitting the solution to evaporate in an open vessel at the ordinary temperature. The crystals of arragonite were minute six-sided prisms and double six-sided pyramids. They change to rhombohedrons of calc spar if left moist ; but if washed and dried at once, they remain permanent. By exposing arragonite to a low temperature, the crystal falls to pieces, in consequence of the change to calc spar which takes place ; or if the prisms hold together, they consist, after the change, of an aggregate of minute particles of calc spar.* Artificial arragonite has been observed in the interior of a copper boiler used to supply hot water for household purposes at Port Eliot Cornwall. The crystals were minute six-sided prisms, and were attached at base to the surface supporting them.† Breithaupt has described a carbonate of lime from a greenstone rock near Zwickau, which consists of alternations of layers of arragonite and calc spar ; and he suggests that the one may be a winter and the other a summer deposit.‡

“ Dimorphism appears therefore to be owing to the different circumstances attending crystallization. Temperature appears to be the main cause ; but it is possible that the nature of the solvent, or the presence of some accidental ingredient in the solution, or the electrical state of the support, may have some effect in changing the molecules ; but in general the only effect of these causes is to produce secondary planes. Rose did not succeed in obtaining arragonite crystals by mixing a strontian salt with the solution of lime, and supposes that the strontia in arragonite has nothing to do with producing the rhombic form.”

The foregoing views are worthy of the most careful attention, particularly in some cases, where their application has not heretofore been looked for. We might cite for instance the species

* Rose, Lond. and Ed. Phil. Mag. 3d ser. XII, 465.

† Lond. and Ed. Phil. Mag. 3d ser. XII, 330 ; 1841.

‡ Pogg. LI, 506 ; 1840.

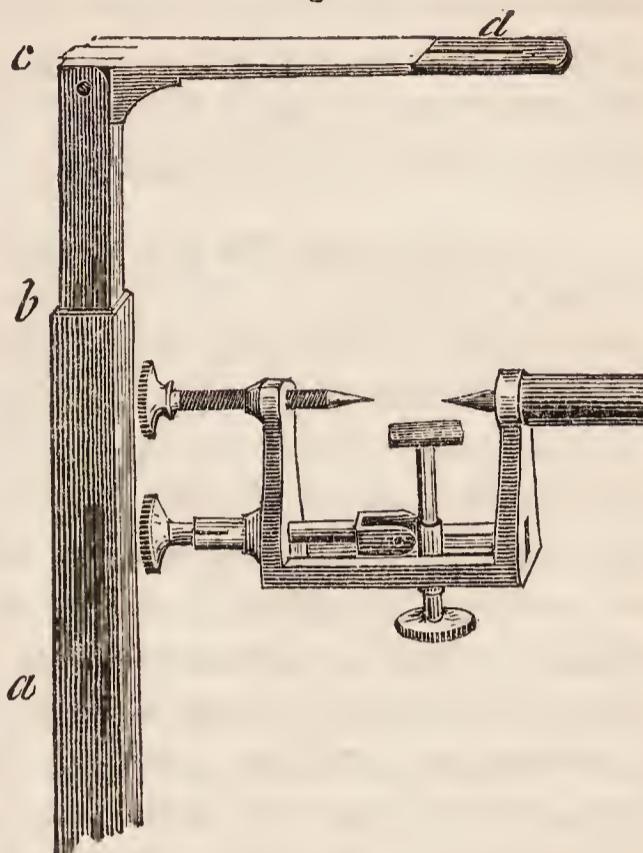
Sillimanite, Kyanite and Andalusite, minerals chemically identical, but mineralogically considered, distinct.

Chapter IV, is on the determination of primary forms; we find under it the following figure and description of an ingenious and useful improvement in the reflecting goniometer of Wollaston, for adjusting the crystals; it is drawn from a German instrument.

The contrivance *acd* is also an important addition. It contains a slit at *d* for sighting the crystals, by using which, one of the lines may be dispensed with. It slides up and down in the part *ab*, and also moves back and forth, parallel with the plane of the graduated circle, on the pivot by which it is attached to the stand of the goniometer.

The chapter on *practical* crystallogeny is an interesting one, and largely illustrated by facts drawn from American sources. Crystallized minerals, especially when the individuals are large, are so rarely homogeneous in structure, that the attention of chemists (as before suggested, p. 8,) ought to be directed specially to a consideration of the circumstances under which the crystal was produced, before deciding definitely as to the essential nature of minute quantities of accidental ingredients, particularly if the mineral owes its origin to crystallization from solution. It seems probable from the observations of Beudant, that symmetrical crystals are seldom produced in clear or homogeneous solutions. Quartz, if pellucid and pure, is almost never regular or normal in the relation of its several secondary planes, while the highly ferruginous quartz, from Expailly, is always in regular bipyramidal prisms, although the quantity of foreign matter mechanically disseminated through the crystals, is such as to make them quite opaque. We see then the risk incurred in assuming that regularly crystallized *opaque* minerals are of course free from accidental impurities.

Fig. 9.



We might extract largely from this portion of the work with profit to our readers, but our space confines us, and we must refer for fuller details to the volume, now easily accessible to all. Under *crystallization by heat*, we find the following new and important observations, drawn from a practical source of the highest authority, and showing the importance of a close reunion between the theoretical and practical arts.

"It has been supposed that complete fusion is necessary for the formation of crystals, or the crystallization of a mineral mass. But late observations have shown, that a high temperature without fusion, or even long-continued friction or vibration, will produce the same result. The tempering of steel is a familiar example. The coarseness or fineness of the grain, or, in other words, the size of the crystallizations, may be varied by the temperature, or the mode of tempering, and a bar that is almost impalpably fine, may in this way be changed to one consisting of crystalline plates an eighth of an inch in breadth. In these instances, the particles must have been free to move, as they are entirely rearranged into large crystals. Mr. N. P. Ames, of Springfield, Mass., who has observed numerous interesting facts bearing upon this subject, informs the author that if a bar of tempered steel, bent in the form of a semicircle, be heated on the inner side, when the heat has reached a certain point, the bar may easily be bent around, and made to curve in the opposite direction. He states that, until the moment when the requisite temperature is acquired, the bar does not yield; but at this moment a change takes place, which is distinctly felt in the hands, and the bar at once bends. He carefully measured the inner and outer curves of the bar, after thus bending it, and found them of the same length as before. This shows that there had been no compression of the particles on the inner side, which would have shortened that side, and therefore, also, that there was actually a removal of particles from the inner to the outer side. He observes, moreover, that the elasticity of the inner and outer sides was the same, which would not have been the case, were the former compressed. By the old method of restoring a warped sword-blade, it was rendered unequally elastic, and would spring more easily on one side than the other; but by the means here explained, the elasticity is perfectly equal on both sides. Here, then, there is a change in the position of the particles throughout the bar, produced by a temperature very far short of fusion. The same experiment was often repeated, and he found that, at every time he bent the steel, the temperature required was a little above that at which it bent the preceding time.

"The change which takes place by friction or long-repeated concussion, is probably owing to the combined action of the heat thus excited,

and the vibration that takes place. Mr. Ames states instances in which a large bar of iron, used as an axle through a heavy wheel of cast iron, broke square off in the middle, after use for a few months ; and in one instance, there were two other fractures on either side of the centre. In these instances, the bar was rendered coarsely crystalline, and was wholly unlike the original iron. The accident which took place in 1842, on the Versailles railroad, was owing to the breaking of an axle, which was rendered brittle by the same cause."

The chapter on "blowpipe characters," contains in a tabular form the most important reactions of the principle oxides and earths with borax, salt of phosphorus and soda, being reduced from the works of Berzelius, Plattner, and others.

The much vexed question of *classification*, occupies the fourth part of the second section of the volume, and we extract the following judicious remarks on the subject, (p.128.)

"The arrangement of objects according to any assumed system, is styled a classification. By using different classes of characters to mark the grand divisions, various modes of arrangement may be made out. Of these there is one *natural* system ; the rest are *artificial* classifications.

"Artificial classifications may sometimes be used to advantage for the convenience of comparison in identifying species ; but farther than this, they only lead to error, by suggesting false affinities and unnatural associations of species. An arrangement of this kind is adopted in this treatise, founded on the crystalline forms. Excepting the purpose for which it is instituted—the determination of the names of minerals—it subserves no important end to the mineralogist ; on the contrary, it brings together species the most unlike, and separates those most closely allied.

"The natural system is a transcript of nature, and consists of those family groupings into which the species naturally fall. In making out such a classification, instead of conforming the whole to certain assumed principles, the various affinities of the species are first ascertained, by studying out all their peculiarities and resemblances, and from these the principles of the system are deduced. There should be no forced unions to suit preconceived ideas, but only such associations as nature herself suggests.

"Unlike the other branches of natural science, mineralogy admits also of a *chemical* classification, or one founded on the chemical constitution of the species ; and as minerals proceed from chemical instead of vital action, there is some reason for the adoption of chemical characters into the natural system. When the chemical relations of the elements are

well understood, it is not too much to assert, that the *chemical* and *natural* systems will be identical.

"In the received chemical systems, analogies and affinities are very generally violated. Some authors arrange minerals according to the electro-positive element (the base) in their composition; and others follow the electro-negative element, (the acid:) and in both cases numerous difficulties obtain. The true system should conform to the one or the other, according to which is the characterizing ingredient; and on this plan, keeping in view also the principles of isomorphism, the chemical classification would not differ from the natural system.

"Carbonate of lime, carbonate of magnesia, carbonate of iron, and carbonate of manganese, are allied chemically—for their bases, lime, magnesia, oxyd of iron, and manganese, are isomorphous—and in physical and crystallographic characters they are also very similar. The group is therefore a natural one. The sulphates of several of the metals constitute a family of vitriols which are always associated in common language, and with equal propriety in science. But most chemical arrangements break up these natural groups, and place sulphate of iron (green vitriol) and carbonate of iron together under iron, sulphate of copper (blue vitriol) under copper, and so on. There is a natural group of alums, a potash-alum, soda-alum, magnesia-alum, &c., which is almost invariably broken up in the chemical systems, one placed with the salts of potash, another with the salts of soda, &c. A single species in mineralogy, pyroxene, is sometimes subdivided and distributed in various parts of the system. This species includes several distinct chemical compounds, as will be seen by referring to *Pyroxene*, in the descriptive part of the treatise; but they are so closely related physically, and, if we consider the isomorphism of the bases, we may say chemically also, that many *chemists* rank them in the same family. The micas evidently form a natural group, yet a chemist separates the rose mica from the others, and places it with other lithia minerals, because it contains a few per cent. of lithia. The natural family of the feldspars and the zeolites are usually broken up in the same manner. A few per cent. of the base will often lead to a dissevering of the closest affinities. The sulphurets of iron, copper, &c. form evidently a natural group chemically as well as mineralogically, yet, without reference to their relations, they are usually distributed under the different metals, although sulphur is here the characterizing ingredient. All the compounds of the metals are generally thrown together; whereas even chemistry, if its principles are well considered, would suggest that the salts of the various metals are in general more nearly allied than the salts and oxyds of the same metal. There can be no more unnatural association of species than the sulphate of iron, (green vitriol,) carbonate of iron, phosphate

of iron, and specular iron. Titanate of iron and specular iron are isomorphous and similar physically, yet chemical systems would separate the two, and place the former along side of other salts of iron.

"Besides, various chemical compounds pass into one another by the gradual substitution of one isomorphous base for another, and although the extremes might be easily arranged in a chemical system, yet the transitions are disposed of with much difficulty. The augite family is a striking example.

"A true chemical system should take into consideration the isomorphous relations of the elements or bases, and not be subservient to any one set of characters. That element in the compound should be assumed for the ground of distinction, which fixes the peculiar features of the species—the acid in some species, the bases in others. In the vitriols, the acid (sulphuric) is the characterizing ingredient; in the alums, sulphuric acid and alumina; and so on. No chemical system can satisfy the demands of the science which does not follow nature's own windings. We would not say that the system of Mohs, adopted in this treatise as the natural system, is perfect; yet, whether we consider it chemically or mineralogically, it will be found to approach more nearly to such a system than any other that has been proposed."

The tables for determination of species are full, and original with the author. We find in the present edition a valuable addition to them—the degree of fusibility expressed in numbers after the manner of expressing hardness, and also a separate arrangement of the species without metallic lustre—according to their *blowpipe characters*. The minerals constituting the scale are, 1. *Gray antimony*,—2. *Natrolite*,—3. *Cinnamon stone*, (variety of garnet,)—4. *Hornblende*, (greenish-black variety,)—5. *Feldspar*,—6. *Chondrodite*. The last fuses with difficulty on the edges. *Infusibility* is expressed by 7.

Descriptive mineralogy, (Part VI,) constitutes of course much the most bulky portion of the book. From what we have said of the elevated character of the introductory chapters of this work, the reader may infer that the descriptive part might have suffered in the hands of an author who valued so highly speculative and theoretical points. It will however be found, that great care and labor has been spent on this portion of the volume. No stone has been left unturned. The foreign journals and treatises have been ably collated; the species have generally been traced to their original authority and all the references authenticated, and those only who have wandered in the mazes of foreign au-

thorities and foreign languages for the purpose in question, can fully appreciate the thankless nature of the labor. The number of species retained is about four hundred and eighty. By careful comparison of analyses, and by researches undertaken expressly for the work, some of the dark points of American mineralogy have been cleared up, and many species turned over to our table of synonyms on a following page.

This part of the work is well illustrated by figures, about seventy of which are new in this edition. The author has added many original figures of American species. We have space only to extract a few notices where the matter is new, and particularly interesting to American readers. We follow the order of the treatise.

“ BORATE OF LIME. *Borocalcius obliquus.*

(*A. A. Hayes*, private communication to the author.)

“ Primary form, an obtuse oblique rhombic prism ; $M : M = 97^\circ 30'$ and $82^\circ 30' - 82^\circ 36'$, (Teschemacher.) Secondary form, the annexed figure ; $M : \check{e} = 147^\circ 30'$, (Teschemacher.) Also in masses having a globular form, consisting of interwoven fibres.

“ Crystals colorless and transparent. Fibrous masses opaque, snow-white, silky, and have a peculiar odor.

“ Composition, according to Mr. A. A. Hayes, a *Hydrous borate of lime* ; the exact constitution has not yet been determined. In warm water the fibrous masses expand and form a consistent paste with more than eight times their volume. Mr. Hayes states that this variety contains more water than the crystals.

“ Obs. This salt occurs quite abundantly on the dry plains near Iquique, S. A., associated with magnesian alum, (Pickeringite of Hayes,) where it was obtained by Mr. J. H. Blake. The crystals are sometimes a quarter of an inch long.” (p. 243.)

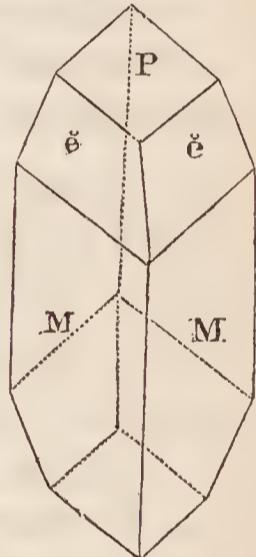
“ CHLOROPHYLLITE. *Stylus foliaceus.*

(“ Esmarkite, Erdmann, Jahresb. 1841, p. 174. Chlorophyllite, Jackson, 1st An. Geol. Rep. of New Hampshire, p. 152. Pinite.)

“ Occurs in six and twelve-sided prisms. Highly foliated parallel to the base of the prism ; sometimes also a prismatic cleavage more or less distinct.

“ H. of basal plane 1·5—2 ; the lateral edges will scratch apatite. G.=2·705, Jackson ; 2·709, Erdmann. Lustre of basal plane, pearly ;

Fig. 10.



of lateral, pearly or greasy to imperfectly vitreous. *Color* green or greenish, greenish-brown—dark olive-green. Translucent to subtranslucent. Folia neither flexible nor elastic; brittle.

“*Composition*, according to Jackson, (communicated to the author,) and Erdmann, (Jahresb. 1841, 174,)

	<i>Chlorophyllite.</i>	<i>Esmarkite, Brevig.</i>
Silica,	45·20	45·97
Alumina,	27·60	32·08
Magnesia,	9·60	10·32
Protoxyd of iron,*	8·24	3·83
Protoxyd of manganese,	4·08	0·41
Water,	3·60=98·32, J.	5·49=98·10, E.

“Traces of phosphoric acid were detected in the chlorophyllite.

“This mineral is closely allied to the hydrous iolite of Bonsdorff, but contains less water. Like that, it is found associated with iolite. Yields water before the blowpipe, and becomes bluish-gray, but fuses only on the edges. With carbonate of soda, effervescence takes place, and an opaque greenish enamel is formed, which becomes darker green in the reducing flame.

“*Obs.* Chlorophyllite is usually associated with iolite in granite, and appears to proceed from the alteration of iolite. It often forms thin folia interlaminated with plates of iolite in the hexagonal prisms of this mineral.

“The chlorophyllite of Jackson occurs abundantly in large prismatic and tabular crystals at Neal’s mine in Unity, Maine, associated with hornblende rocks containing iron and copper pyrites. The same mineral occurs with iolite at Haddam, Connecticut, and has been called Pinite. The Esmarkite of Erdmann is found in granite near Brevig in Norway.

“The name Chlorophyllite, given this species by Dr. Jackson, is derived from *χλωρος*, *green*, and *φυλλον*, *leaf*, and alludes to its structure and color. The name Esmarkite was previously appropriated to a variety of Datholite.

“It is probable that both the hydrous iolite of Bonsdorff and chlorophyllite have proceeded from the alteration of iolite, and the hexagonal forms the crystals present may have been derived from the original iolite, instead of being the actual crystallization of the hydrous mineral. Gigantolite, Pinite, and Fahlunite, may also be altered forms of other minerals, and probably of iolite.” (pp. 306, 307.)

* If the iron in these analyses was protoxyd, why should the sum of the alumina and iron be equal? (35·91 and 35·84, diff. ·07.) We would suggest a query if it is not peroxide.—B. S., Jr.

STELLITE.—This mineral has been described by Dr. Thomson,* and a mineral was mentioned by Dr. Beck in an article in this Journal, (Vol. XLIV, p. 54,) as identical with it, which has been found at Bergen Hill, and widely circulated under the name of Thomsonite. This mineral yielded to Dr. Beck's analysis,—silica 54·60, lime 33·65, magnesia 6·80, oxyd of iron with a little alumina 0·50, water and carbonic acid 3·20.

"Mr. A. A. Hayes has analyzed the same mineral with quite a different result, as follows:—Silica 55·96, lime 35·12, soda 6·75, potash 0·60, alumina and magnesia 0·08, protoxyd of manganese 0·64, water (hygrometric) 0·16=99·31. The large per centage of soda and the proportion of silica and lime, would seem to ally the species to *Pectolite*, from which, however, it appears to be removed by containing no water."

"The author has compared specimens of the stellite of Bergen Hill with the foreign pectolite in Mr. J. A. Clay's cabinet at Philadelphia, and finds them closely similar in external character; moreover, Frankenheim, in a late article, makes pectolite an anhydrous mineral, stating that the water varies, and is not an essential ingredient." (p. 336.)

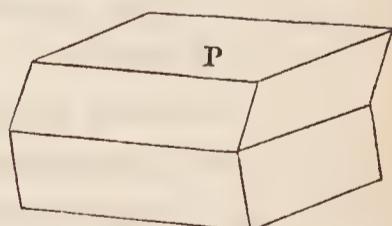
HAYDENITE. *Chabazius monoclinatus*.—This interesting species is found in company with a rare and curious modification of Heulandite, which M. Levy has endeavored to establish as a distinct species under the name of Beaumontite, but which Mr. Alger has shown (this Vol. p. 233) to be Heulandite. The *Haydenite* was also *re-established* by Levy on crystallographic grounds, but as it is still doubtful whether its primary may not be a rhombohedron, like chabazite, instead of a rhombic prism, a chemical analysis was undertaken by B. Silliman, Jr., to settle the question. We copy the figure given by Mr. Dana, and from the appendix the chemical examination.

"Primary form, an oblique rhombic prism, (Levy.) $M : M = 98^\circ 22'$, $P : M = 96^\circ 5'$. Cleavage: lateral and basal, perfect; the latter little the most so. Twin crystals compounded parallel with P, as in the annexed figure.

"H.=3. G=2·136—2·265, (Silliman.) Lustre vitreous; bright. Color brownish-, greenish-, or wine-yellow. Translucent—transparent. Brittle.

"Dissolves partially without gelatinizing in sulphuric acid, and on cooling deposits crystals of alum. Fuses with difficulty before the blow-pipe—tinges the outer flame violet. Heated in a glass tube alone, it gives off a slight empyreumatic odor, and deposits water.—(Silliman.)

Fig. 11.



* Outlines of Min. and Geol. Vol. I, p. 313.

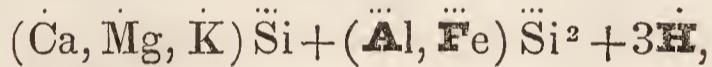
"Composition,—

Silica,	-	-	-	-	-	-	56·831
Alumina,	-	-	-	-	-	-	12·345
Protoxyd of Iron,	-	-	-	-	-	-	8·035
Lime,	-	-	-	-	-	-	8·419
Magnesia,	-	-	-	-	-	-	3·960
Potash,	-	-	-	-	-	-	2·388
Water,	-	-	-	-	-	-	8·905
							100·883

"*Obs.*—Haydenite was first described and named by Cleaveland. It has since been considered chabazite, and was lately restored to its place as a species by Levy. It occurs coating hornblendic gneiss in fissures at Jones's Falls, a mile and a half from Baltimore. The crystals seldom exceed a line in length, and are nearly rhombs in shape. They are usually coated with a brownish-green hydrate of iron, which is easily separated, and leaves the surface smooth and bright. Occasionally crystals are met with, consisting wholly of this hydrate of iron. The Haydenite is associated with Heulandite in minute crystals." (pp. 342, 526.)

This species seems to deserve a distinct consideration, notwithstanding its resemblance in some respects to chabazite.

The iron was estimated as protoxyd from the excess found in the analysis, (103·355.) But there is reason to believe that the lime might have been in excess; allowing for this, and taking the iron as *peroxyd*, the formula will be



which is the formula given for some chabazites, (from Parsborough, see Dana's Mineralogy, p. 559,) excepting half the proportion of water. The analysis as it stands leads to the less probable formula—

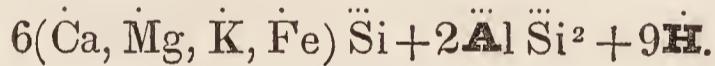
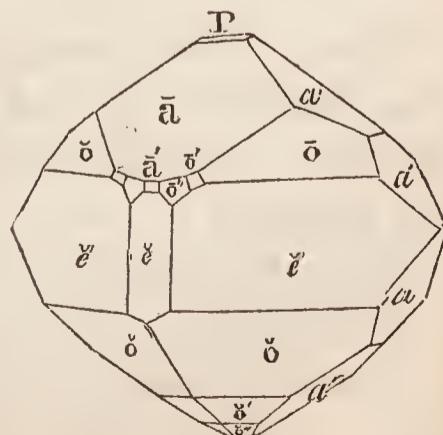


Fig. 12.

Under *Datholite* we have the accompanying figure of a rare and interesting form of this mineral from the new locality of Roaring Brook, Cheshire, Conn. (p. 342.)

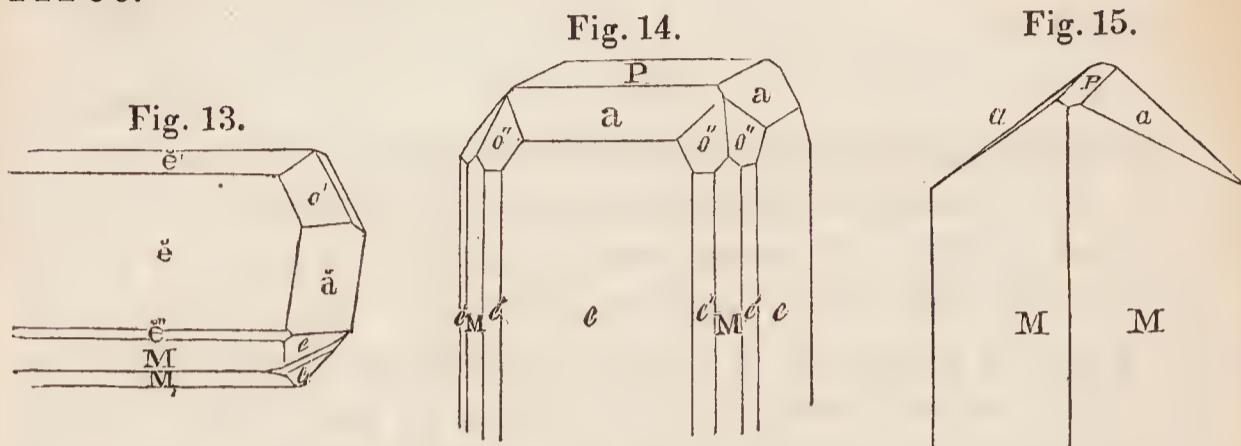
EPIDOTE.—Haddam, Conn., furnishes crystals of this species having the form



shown in fig. 13. Some of the individuals from this locality are six to eight inches in length, and always macles.

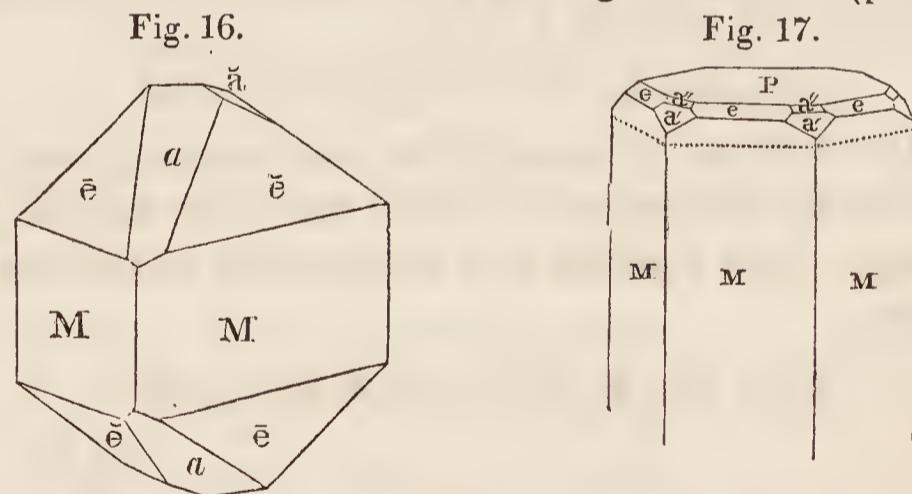
IDOCRASE.—Amherst, in New Hampshire, furnishes the form represented in fig. 14.

ANDALUSITE.—A crystal of Andalusite from Westford, Mass., shown in fig. 15, was measured by Mr. Teschemacher, $P : a = 144\cdot50$.



CHONDRODITE.—We have at last a figure and the angles of this rarely crystallized species as follows, (Fig. 16.)

"Primary form, an oblique rhombic prism; $M : M = 112^\circ 12'$? Haüy. Secondary form: $M : M = 112^\circ$ and 68° , $M : \check{e} = 136^\circ$, $M : \bar{e} = 157^\circ$, $\check{e} : \check{e}$ (adjacent) = 80° , $a : a$ (over the summit) = 85° , $\bar{e} : \bar{e} = 89^\circ$, $\check{e} : \bar{e}$ (over a) = 127° , \check{a} on the edge $\check{e} : \check{e} = 167$. The figure is drawn from a specimen in the collection of J. A. Clay, Esq. of Philadelphia. The angles were taken with the common goniometer." (p. 388.)

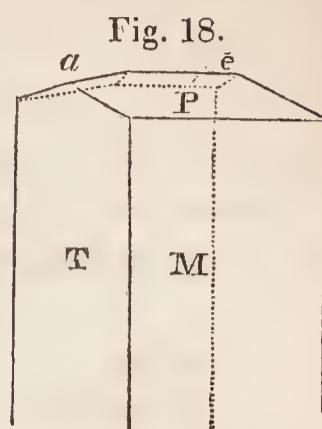


BERYL.—The beautiful and almost unique beryls from Had-dam, described by Prof. Johnston (in this Journal, Vol. XL, p. 401) are rarely modified by secondary planes. Fig. 17 shows one with the planes $a' a''$ and e . The dotted line marks the boundary between the pellucid and milky portions.

SILLIMANITE. *Epimecias Sillimanianus.*

This interesting mineral has been the subject of much speculation. The following figure and angles are taken from a specimen in the cabinet of B. Silliman, Jr. and found at Norwich, Ct.

"*Primary form*, an oblique rhombic or rhomboidal prism; M : T = 110° to 98°, crystals having the faces M smooth and plain, give the latter, which therefore appears to be the correct angle of the prism. *Secondary form*, the annexed figure; P : M = 105°, P : e = 133° 30', M : e = 120° 30', P : a = 132°, (D.) The terminal planes dull and hardly smooth. *Cleavage* highly perfect, parallel to the longer diagonal, and producing brilliant surfaces; parallel to M indistinct. Crystals usually long and slender. Occurs also long fibrous, parallel, or slightly divergent.



"H.=7—7.5. G.=3.2—3.238, D.; 3.259, Norton. (Yorktown.) *Lustre* vitreous, inclining to pearly; hardly shining on M, but splendid on the face of perfect cleavage; parallel to P, vitreous, inclining to resinous. *Streak* white. *Color* hair-brown—grayish-brown. Translucent. *Fracture* uneven, parallel to P. Brittle. The long crystals are detached from the rock entire, with great difficulty, on account of their frangibility.

"*Composition*, according to Bowen, (Sill. Jour. viii, 113,) Muir, (Thom. Min. I, 424,) Connell, (Jameson's Jour. xxxi, 232,) and Norton, performed for this work, in the laboratory of B. Silliman, Jr.

	Chester, Conn.*	Chester.	Chester.	Yorktown, N. Y.
Silica,	42.666	38.670	36.75	37.700
Alumina,	54.111	35.106	58.94	62.750
Zirconia,		18.510		
Oxyd of iron,	1.999	7.216	0.99	2.287
Water,	0.510			
	99.286, B.	99.502, M.	96.68, C.	102.739, N.

"The analyses by Connell and Norton show that this mineral contains no Zirconia.

"Before the blowpipe, both *per se* and with borax it is infusible.

"*Obs.* The crystal here figured appears to have dissimilar lustre on M and T, and this, as well as the secondary planes, indicates that the primary is probably a *rhomboidal* prism. In composition, Sillimanite is very close to Kyanite, if they are not identical; yet its bright and easy cleavage shows that it is mineralogically distinct from that species." (pp. 377, 378,)

Connell proposed (Jameson's Jour., Vol. xxxi, p. 232) the union of Sillimanite with Kyanite, and Berzelius† in his report for this

* Chester, Ct. is quoted in Thomson and other foreign authors as Saybrook, Ct.

† Arsberte Kemi och Min. (Swedish edition,) 1843, p. 202.

year, suggests the union of Sillimanite, Kyanite,* and Andalusite, under the general formula $\text{Al}^3 \text{Si}^2$. There are strong reasons for believing that silicate of alumina is a dimorphous substance, and on this supposition we may consider Sillimanite one of its forms. *Mineralogically* Sillimanite is certainly distinct.

IOLITE.—We have the following analyses of Iolite from Haddam, Ct. and Unity, in New Hampshire, by Dr. Jackson. (p. 406.)

	Haddam.	Unity, N. H.
Silica,	48·35	48·15
Alumina,	32·50	32·50
Magnesia,	10·00	10·14
Protoxyd of iron,	6·00	7·92
Prot. manganese,	0·10	0·28
Water,	3·10	0·50
	100·05	99·49

ILMENITE.—“The *Washingtonite* of Shepard, a variety of Ilmenite, has been analyzed by J. S. Kendall in Dr. C. T. Jackson’s laboratory, and found to contain titanic acid 25·28, peroxyd of iron 51·84, protoxyd of iron 22·86=99·98. It appears therefore to be nearly identical in composition with the hystatic iron ore of Breithaupt, or the *Hystatite* variety of this species.” (p. 527.)

If we were to form our estimate of the progress of American mineralogy by taking into view the number of exploded species of American minerals only, we should be forced to conclude that such *progress* was of rather an equivocal nature. But we must bear in mind that the science is burthened with hundreds of synonyms of European minerals which still hold a place in the index of the present work, while too many of the bad American species have been proposed by *foreign* authors. There can be no objection to giving the following alphabetical list of American species which have been proposed and subsequently abandoned. The list is made out from our own opinions, and it is too much to expect that it will meet in all cases the views of authors.

* The Kyanite from Chesterfield in Massachusetts, has been recently analyzed by one of my pupils, (Mr. C. H. Rockwell of Norwich.) The specimen was finely crystallized, transparent, and azure colored: it yielded

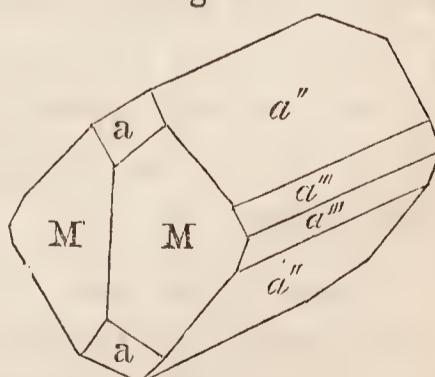
Silica, - - - - -	42·74
Alumina, - - - - -	57·90
Iron, - - - - -	trace.
	100·64

This analysis adds farther confirmation to the views expressed in the text.—
B. S., Jr.

Names proposed.	Authors.	Identical with.
Acadiolite,	Thomson,	Chabazite.
Baltimorite,	Thomson,	Picrolite, or fibrous serpentine.
Beaumontite,	Levy,	Heulandite.
Brucite,		Chondrodite.
Bytownite,	Thomson,	Scapolite? [ite, and heavy spar.
Calstronbaryte,	Shepard,	Mechanical mixture of calc spar, strontian-
Catlinite,	Jackson,	A clayey rock, and not a mineral.
Chiltonite,	Emmons,	Prehnite.
Cleavelandite,	Brooke,	Albite.
Danaite,	Hayes,	Mispickel.*
Deweylite,	Emmons,	Serpentine.
Danburite,	Shepard,	Mechanical mixture of silicate of lime and
Edwardsite,	Shepard,	Monazite. [quartz.
Emmonsite,	Thomson,	Impure strontianite.
Eremite,	Shepard,	Monazite.
Eupyrchroite,	Emmons,	Mammillary apatite.
Fowlerite,		Manganese spar.
Gymnite,	Thomson,	Impure serpentine.
Hudsonite,	Beck,	Variety of pyroxene.
Jeffersonite,	Keating,	Pyroxene.
Ledererite,	Jackson,	Gmelinite, var. Chabazite.
Lederite,	Shepard,	Sphene.
Lincolnite,	Hitchcock,	Heulandite.
Marmolite,	Nuttall,	Serpentine.
Maclurite,		Chondrodite.
Masonite?	Jackson,	Foliated hornblende? chloritoid?
Microlite,	Shepard,	Pyrochlore?
Mullicite,	Thomson,	Vivianite.
Nuttallite,		Scapolite.
Peristerite,	Thomson,	Feldspar.
Perthite,	Thomson,	Feldspar.

* Mr. Teschemacher (in Dr. Jackson's Report on the Geology of New Hampshire, p. 167) has given a figure of "Danaite" with the following angles; $M : M = 112^\circ$; $a : a = 121^\circ 30'$, $a'' : a'' = 100^\circ 15'$, (see the annexed figure, which is Teschemacher's figure inverted in position so as to correspond with the usual figures of Mispickel.) Scheerer has described a similar cobaltic variety from Skutterud, which gave the angles $M : M = 111^\circ 40' - 112^\circ 2'$, $a : a = 121^\circ 30'$. The angles do not differ essentially from those of Mispickel. Rammelsberg considers iron and cobalt isomorphous, and gives for the formula of the species Mispickel, $(Fe, Co)(S_2, As_2)$. (See pages 475, 476 and 568 of Dana's Mineralogy.)

Fig. 19.



Names proposed.	Authors.	Identical with.
Pickeringite,	Hayes,	Magnesian alum.
Polyadelphite,	Thomson,	Brown garnet.
Raphitite,	Thomson,	Hornblende ?
Rensselaerite,	Emmons,	Steatitic pyroxene or pseudomorphous steatite.
Retinalite,	Thomson,	A doubtful serpentine compound.
Scoharite,	Macneven,	Heavy spar, with 6 to 9 per cent. of silica
Stellite, (of Bergen hill,)	Pectolite.	[mechanically mixed.]
Terenite,	Emmons,	Doubtful—altered scapolite or augite.
Tephroite,	Breithaupt,	Troostite.
Torrelite,	Thomson,	Columbite from Middletown, Ct.
Torrelite,	Renwick,	An impure red jasper.
Washingtonite,	Shepard,	Ilmenite.
Xanthite,	Mather,	Idocrase.

Catalogue of American localities and minerals.—This is one of the many novel features of the present edition. Besides full and minute specifications of American localities under the several species, we have them here arranged geographically, beginning with Maine and following the coast. This list is designed to aid the mineralogical tourist in selecting his routes and arranging the plan of his journey.

“In making out this catalogue, the names of those minerals which are obtained in good specimens at the several localities, are distinguished by italics. When the specimens are remarkably good, an exclamation mark (!) has been added, or two of these marks (!!) when the specimens are quite unique. If a locality that has afforded peculiarly fine specimens is now exhausted, the exclamation mark has been inverted (i). The more exact position of localities may in most instances be ascertained by reference to the description of the species in the preceding part of the treatise.”

Chemical Classification, Part VII.—We have already extracted (p. 374) the author’s views, in which the strictly chemical character of the arrangement adopted in the Treatise is explained. The following additional remarks are cited from the introduction to a *second* classification by the author, corresponding more nearly with other chemical arrangements. Speaking of the natural system, he says:

“It takes into view, it is true, the external characters; but as these depend upon the chemical constitution, and proceed from it, they are indications of the composition, and unless followed too implicitly and without a general survey of the whole subject, will not lead to impor-

tant variations from a strict chemical method. It has been shown that owing to the isomorphism of bases, the old modes of chemical classification are wholly unsatisfactory; and the difficulties have of late become so great that some authors have fallen into an alphabetical arrangement, rather than be bound down to the usual chemical rules. Moreover, it has been remarked, that the union of the salts of metals into a family is more correct on chemical principles than a distribution of them under the several metals: and that as the salts of lime, magnesia, alumina, are also salts of metals, the former fall naturally and chemically into close associations with the latter, as in the system adopted.

" Yet it is convenient to the chemist and to the metallurgist, to view the ores of the several metals by themselves, and in general to be able to survey at a glance the compounds of each element. For this purpose, the following classification has been made out. Except in the metallic ores, the mineral species have been kept together, as much as possible, in natural families, by taking into consideration the isomorphous relations of the elements; and it is believed that the classification here proposed will be found to combine many of the more important advantages of both systems. *Chemists* treat of the alums as a family, of the various feldspars as another, and the varieties of hornblende and augite another, and so on; and instead of scattering them in the different parts of a system, as was formerly done, arrange them together and treat of them as distinct groups, although differing so much in chemical constitution. These natural families are still retained in the method of arrangement here brought forward."

To this table are added the chemical formulas for composition, derived from the most recent authorities.* The chemical symbols, inasmuch as they speak more directly to the eye, have been adopted in preference to the mineralogical, although printed with more difficulty.

The author has ingeniously substituted the black type (**H**, for example) in place of the crossed letters used by Berzelius for double atoms.

An example of these new symbols for expressing a double dose of base, is given in the formula for *Haydenite* in the present article. It has the great advantage of being easily followed and imitated, while the type introduced by Berzelius can only be had at the expense of punches and matrices expressly made for the

* Particularly from Rammelsberg's Handwörterbuch der Chemischen Theils der Mineralogie; 2 vols. 8vo. pp. 442 and 326: Berlin, 1841:—And, Erstes Supplement, (first supplement to the same,) 8vo. pp. 156: Berlin, 1843. This supplement is to be continued biennially.

purpose. We have found it impossible to procure the type of Berzelius even in London, ready made. Probably it is owing to this difficulty that these useful symbols have been so slowly introduced out of continental Europe. The double type gives instant notice of the double base, and we shall hereafter employ them in this Journal.

We may add that the mineralogical cabinet of Yale College has been recently arranged, nearly, on this plan. The tabular arrangement of these formulas secures many advantages not attained when they are distributed through the volume each under its species.

Rocks and mineral aggregates.—Part VIII. of this volume is devoted to a description of the various mineral aggregates which form the rock masses of our planet. It is not usual to include these in a mineralogical treatise, nor are they treated here in any other than a mineralogical way. There is an expectation on the part of most general readers of finding, when they take up a mineralogical book, an account of the principal rocks, and when they search the index in vain for such words as porphyry, granite, basalt, and the like, they very naturally feel a degree of disappointment. This chapter is intended to meet that expectation. Its arrangement presents at every step the same admirable power of generalization and order which so eminently distinguish all the author's works.

The work is brought to a close by a mineralogical bibliography posted up to the present time: in it are registered all the important publications on the subject, from Theophrastus down, and in the American portion, every paper on the subject, which has been published, even in a transient magazine, is recorded. The student in his researches will duly appreciate the value of this unpretending catalogue. Nor must we fail to mention the *index*, the key to technical knowledge, and which is in the present case most satisfactorily full and comprehensive; every known name and synonym ever used in the science is introduced.

But we must abruptly close this notice, already too long, with the remark, that it gives us pleasure to believe that it requires but few works like the present, to give *American science* a name, which will merit, if it does not receive, the respect of the scientific world.

B. S., Jr.

A N A L Y S I S
OF
M E T E O R I C I R O N .

Analysis of Meteoric Iron from Burlington, Otsego County, N. Y.— Dr. L. C. Beck, in his report on the mineralogical survey of New York, p. 383, makes mention of a mass of malleable iron, said to be native, which he saw in the cabinet of the Albany Institute. It does not appear that any chemical examination was made of the mass.

Last November, Mr. E. C. Herrick, being in Geneva, N. Y., received from the hands of Prof. James Hadley of that place, a mass of metallic iron, which Prof. H. assured him was a portion of the same specimen mentioned by Dr. Beck in his Report above quoted, and that both belonged to a larger mass, which when found was supposed to weigh from one hundred to two hundred pounds avoirdupois. Mr. Herrick also learned, that Dr. Eli Pierce of Athens, N. Y. was the gentleman who originally communicated the specimens and information to Dr. Hadley.

On Mr. Herrick's return to this place, the mass was placed in my hands for examination. Its strong resemblance to the iron found in North Carolina, by Prof. Olmsted, (this Journal, Vol. xvii, p. 140,) and examined subsequently by Prof. Shepard, (Vol. xl, p. 369,) immediately struck me; it was divided by broad laminæ, crossing each other at angles of 60° and 120° , cutting up the surfaces into triangular and rhombohedral figures. It broke with a hackly fracture and only with the greatest difficulty, on the thinnest edges.

Two deep and broad sutures marked its two most regular and opposite faces, made by the wedge or chisel by which the blacksmith (into whose hands the larger mass unfortunately came) severed it from the adjoining portion. It bore the marks of having been intensely heated in the smith's forge, and numerous microscopic crystals, of a black color and brilliant lustre, covered some parts of its surface. They resembled phosphate of iron, but were too small to be detached. I had no doubt on first seeing the mass, of its extra-terrestrial origin, which opinion was confirmed by the following analysis performed in my laboratory by Mr. C. H. Rockwell, one of my pupils.

It dissolved quickly and completely in pure nitric acid, with the application of a gentle heat. The solution tested with nitrate of silver gave no cloudiness, showing the absence of chlorine. Still farther to settle the question, of the presence of chlorine, the mass was put in a clean capsule and placed over a water bath, covered on the plate of an air pump by an air-tight jar. After exposure to this humid atmosphere for a week, it was taken out and washed with pure water into the capsule, which contained also water of condensation from the mass. These washings, tested with nitrate of silver, remained quite unclouded. After the heat to which the mass had been subjected in the smith's forge, it could hardly be expected that we should find any traces of chlorine, if

it ever existed. The solution of the iron in nitric acid yielded, with the usual process for separating iron from nickel,

Metallic iron, - - - - -	92.291
Do. nickel, - - - - -	8.146
	100.437

No traces of other substances could be detected in the iron. Specific gravity 7.501.

With a view to obtain all the information possible in relation to this interesting meteoric iron, Mr. Herrick addressed a letter of inquiry to Dr. Pierce, which brought the following particulars. He says: "In the year 1819, I procured some two or three masses of native iron (as it appeared to be) from the farmer who first turned it over with his plow, in a field near the north line of the town of Burlington, Otsego Co., N. Y. These consisted of remnants of an entire mass originally supposed to weigh between one and two hundred pounds, and found several years before. Before I had any knowledge of its existence, it had been in the forge of a country blacksmith, and the whole heated in order to enable him to cut off portions for the manufacture of such articles as the farmer most needed. The smith assured me that he never worked stronger, tougher, or purer iron; that it made the best horse-shoe nails. All the fragments that remained I immediately secured, and presented them to Prof. Hadley, whose lectures I was then attending. These were in two or three irregular masses, in all some eight to twelve pounds, with the marks of the chisel used in cutting while in a heated state. In conversation with the farmer who found the original mass, I could only learn that in plowing the field he found a stone very heavy, rusty on the top, which lay above the surface. From its great specific gravity, he was induced to examine more particularly, and thinking it might be iron he carried it to his blacksmith, who, finding it iron, had worked up the most of it into horse-shoes, nails, &c., as the farmer needed. The latter told me that he had seen several small specimens of what appeared to be similar, whilst plowing the same field, but a diligent search made by me at the time proved fruitless in discovering any other specimens, the field being at that time in meadow.

" It was the opinion of Prof. Hadley, on the first examination, that it was of meteoric origin. Why it was not completely buried in falling, may be accounted for by the fact, that the ground on which it was found was hard and strong. Yours, &c. E. PIERCE."

Measures have been taken to secure as much of this interesting mass as can now be obtained, for the mineralogical collection in Yale College.

B. SILLIMAN, Jr.

Yale College Laboratory, March 20, 1844.

